HYDROLOGIC RESOURCE MONITORING PARAMETERS

Surface Water Quality

Brief Description: The quality of surface water in rivers and streams, lakes, ponds and wetlands is determined by interactions with soil, transported solids (organics, sediments), rocks, groundwater and the atmosphere. It may also be significantly affected by agricultural, industrial, mineral and energy extraction, urban and other human actions, as well as by atmospheric inputs. The bulk of the solutes in surface waters, however, are derived from soils and groundwater baseflow where the influence of water-rock interactions are important [see groundwater quality; karst activity; soil and sediment erosion; soil quality; streamflow; wetlands extent, structure and hydrology]. Selecting the variables to be measured depends on the objectives and economics of the monitoring. This is a complex matter because there are so many potential chemical, physical and biological substances that could be important in any one area. From the viewpoint of geoindicators, the following variables may be selected:
1. Basic variables
Metals and trace elements: Al, Sb, As, Cd, Cr, Cu, Pb, Hg, Se, Ag, Zn.
Nutrients: ammonium, nitrate, nitrite, total N, orthophosphate, total P.
Major constituents and dissolved solids: Ca, Mg, Na, Cl, SO_4, HCO_3, TDS.
Direct field measurements: acidity, alkalinity, dissolved O, pH, temperature.
Selected organic compounds of environmental significance: 2,4-D; 2,4,5-T; phenol, chlorophenols, cresols, atrazine, cyperquat, paraquat, benzidine, DDT, malathion.
2. Additional parameters
Of importance to human health: Ba, Be, F, Mo, Ni, V, radionuclides (gross alpha, gross beta, ^{222}Rn.
Of importance to agriculture - B.

Significance: Clean water is essential to human survival as well as to aquatic life. Most is used for irrigation, with lesser amounts for municipal, industrial, and recreational purposes: only 6% of all water is used for domestic consumption. An estimated 75% of the populations of developing nations lacks adequate sanitary facilities, and wastes are commonly dumped into the nearest body of flowing water. Pathogens such as bacteria, viruses and parasites make these wastes among the world's most dangerous environmental pollutants: water-borne diseases are estimated to cause about 25,000 deaths daily. Water quality data are, thus, essential for the implementation of responsible water quality regulations, for characterizing and remediating contamination, and for the protection of the health of humans and aquatic organisms.

Environment where Applicable: The main environments are those where surface water is used for human consumption or other societal uses, or where important freshwater fisheries, sensitive aquatic habitats or valuable wetlands are involved.

Types of Monitoring Sites: These are determined by the location of known sources of pollution, ease of access to sampling sites, presence of streamflow gauges and required facilities. For those watersheds where problems are known or suspected, the areal water quality should be determined by a network of systematically operated sampling stations. Sampling for stream water quality should be conducted at or near streamflow gauge stations to allow the computation of contaminant levels.

Method of Measurement: Sampling and analysis for water quality determination varies with site conditions and the constituents to be measured. Typically, samples are collected so as to represent any changes in depth and width of the water body or stream, and in sufficient quantity to permit replicate analyses.

Frequency of Measurement: Changes in surface water quality may be quite rapid (e.g. in response to weather variations and flooding). Water samples taken from streams are usually collected at specified intervals of time. Continuous, real-time monitoring systems therefore provide the most complete information. Comprehensive analysis for water-quality monitoring is, however, expensive, and for most diagnostic purposes sample collection and analysis 4-6 times yearly may suffice, with sampling twice yearly for radionuclides and organic chemicals.

Limitations of Data And Monitoring: Long-term records of key parameters such as pH, HCO_3, NO_3, and Cl in surface waters are of value in detecting trends in environmental quality, but they may suffer in terms of accuracy due to changes in analytical or sampling methods and personnel.

Possible Thresholds: For each parameter measured, thresholds have been set by national and international organizations (eg. WHO), according to the purpose for which the water is being used.

Key References:

Hirsch, R.M., W.M.Alley & W.G.Wilber 1988. Concepts for a national water-quality assessment program. U.S. Geological Survey Circular 1021.

Meybeck, M., D.Chapman & R.Helmer (eds) 1989. Global freshwater quality - a first assessment. Oxford: Basil Blackwell.

Smith, J.A., P.J.Witowski & T.V.Fusillo 1988. Manmade organic compounds in the United States - a review of current understanding. U.S. Geological Survey 1007.

Related Environmental and Geological Issues: There are many causes of changes in the quality of surface water, including acid precipitation, urbanization, mining, agricultural development, land clearance and deforestation, as detailed above.

Overall Assessment: Surface water quality is one of the most fundamentally important environmental variables to be monitored. It is also of value as an indicator of short-term improvement or deterioration in the environment, when implementing remediation policies.

Source: This summary of monitoring parameters has been adapted from the Geoindicator Checklist developed by the International Union of Geological Sciences through its Commission on Geological Sciences for Environmental Planning. Geoindicators include 27 earth system processes and phenomena that are liable to change in less than a century in magnitude, direction, or rate to an extent that may be significant for environmental sustainability and ecological health. Geoindicators were developed as tools to assist in integrated assessments of natural environments and ecosystems, as well as for state-of-the-environment reporting. Some general references useful for many geoindicators are listed here:

Berger, A.R. & W.J.Iams (eds.) 1996. Geoindicators: assessing rapid environmental change in earth systems. Rotterdam: Balkema. The scientific and policy background to geoindicators, including the first formal publication of the geoindicator checklist.

Goudie, A. 1990. Geomorphological techniques. Second Edition. London: Allen & Unwin. A comprehensive review of techniques that have been employed in studies of drainage basins, rivers, hillslopes, glaciers and other landforms.

Gregory, K.J. & D.E.Walling (eds) 1987. Human activity and environmental processes. New York: John Wiley. Precipitation; hydrological, coastal and ocean processes; lacustrine systems; slopes and weathering; river channels; permafrost; land subsidence; soil profiles, erosion and conservation; impacts on vegetation and animals; desertification.

Nuhfer, E.B., R.J.Proctor & P.H.Moser 1993. The citizens' guide to geologic hazards. American Institute for Professional Geologists (7828 Vance Drive, Ste 103, Arvada CO 80003, USA). A very useful summary of a wide range of natural hazards.